

PATENT ABSTRACTS OF JAPAN

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(54) JOINT STRUCTURE FOR MEMBERS

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a joint structure in which the penetration of a joint surface metal is obviated and the joint strains between two members varying in the coeffs. of expansion are decreased by metallurgically coupling the two members by holding a melt phase of an alloy contg. an active metal between these members.

SOLUTION: The members of the joint structure of the metal-metal, the metal-ceramics are joined across the melt phase of the M-X (X is the active metal) alloy. The joint surface of the metallic member consists of the metal Y which does not form the alloy with the metal M or a metallic material formed with an oxidized film or nitrided film which does not cause the reaction of the molten metal M. Y does not melt into the metal M in the case of the metal Y. The penetration of the metallic component into the metal M does not arise in the case of the metallic material formed with the oxidized film and the nitrided film. The active metal X added into the metal M is diffused into the metal Y or the oxidized film and nitrided film, by which the melt M-X alloy and the metal Y or the melt M-X alloy and the oxidized film and nitrided film are metallurgically coupled.

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CLAIMS

[Claim(s)]

[Claim 1] It is the structure joined in metallurgy on both sides of the melt phase of an alloy in between. two members which the plane of composition of one [at least] member becomes from a metal -- M-X (X is an active metal) -- Junction structure of the member characterized by coming to join Metal Y to alloy M-X in metallurgy when this joint metal side consists of a metal Y which does not react with the melt of Metal M and exists in the state of solid phase at the melt temperature at the time of junction of this M-X alloy and this active metal X is spread to this metal Y.

[Claim 2] Junction structure according to claim 1 which is the alloy which uses as a principal component a kind or two sorts or more of metals with which the above-mentioned metal M was chosen from In, Sn, Au, Ag, Cu, AL, Pd, Zn, Pb, and Cd, and is the metal with which Metal Y was chosen from Cr, Mo, and W.

[Claim 3] Claim 1 the above-mentioned metallurgical junction is [claim] with a low, or junction structure given in 2.

[Claim 4] It is the structure joined in metallurgy on both sides of the melt of an alloy in between. two members which one [at least] member turns into from a metal -- M-X (X is an active metal) -- A kind or two sorts or more of metals of this metal member with which the plane of composition was chosen from (Fe, nickel, Co) at least, and a kind or two sorts or more of metals chosen from (Cr, AL, Si) with the alloy used as a principal component And junction structure of the member characterized by consisting of 1% or more of alloy if it is in Cr, it is in AL 10% or more and it is in Si 1% or more, and coming to form in the front face of this alloy the oxide film of Cr included as a component, AL, or Si.

[Claim 5] Junction structure according to claim 4 which is the alloy which uses as a principal component a kind or two sorts or more of metals with which the above-mentioned metal M was chosen from In, Sn, Au, Ag, Cu, AL, Pd, Zn, Pb, and Cd.

[Claim 6] two members which one [at least] member turns into from a metal -- M-X (X is an active metal) -- the junction structure of the member characterized by being the structure joined in metallurgy on both sides of the melt phase of an alloy in between, and coming to nitride this joint surface of metal.

[Claim 7] Junction structure according to claim 1 to 6 which is the metal with which the above-mentioned active metal X was chosen from Ti, Zr, Nb, and Ta.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention is concerned with the junction structure of a member, and relates to the junction structure which can make small junction distortion of two members from which a coefficient of expansion differs in more detail.

[0002]

[Description of the Prior Art] By junction of a metal-metal or metal-ceramic, in case the member from which a coefficient of thermal expansion differs is joined, it joins to wax material using a soft metal in many cases. For example, noble metals, such as low-melt point metals, such as In, Sn, Zn, Pb, and Cd, and Ag, Au, Pt, Pd, are pushed, it is a metal soft in general, and if it joins using these, the thermal strain produced by the difference in a coefficient of thermal expansion will be eased by the plastic deformation or elastic deformation of these metals. Under the present circumstances, the problem is that the penetration of the plane-of-composition metal of joint material happens into these wax material metal. Consequently, a wax material metal hardens, the deformation resistance of a wax material metal becomes large, and the residual stress of a joint becomes large. A ceramic may be destroyed when the worst [one side of a member is a ceramic, and]. Since this penetration is an unescapable phenomenon metallurgically, consideration is paid to how conventionally, increase of the deformation resistance by penetration makes residual stress small, after admitting. The most general approach is inserting the interlayer who has an in-between coefficient of expansion. making the differential thermal expansion between adjacent members as small as possible, and making residual stress small by an interlayer's insertion, is performed -- **** -- it does not pass but the present condition is that fundamental solution is not measured.

[0003]

[Problem(s) to be Solved by the Invention] The place which this invention was made in view of this situation, and is made into the purpose is that there is nothing or a thing which uses as an offer plug new junction structure which can be made into the minimum about the penetration of a plane-of-composition metal.

[0004]

[Means for Solving the Problem] this invention person acquired the following knowledge, as a result of inquiring wholeheartedly about the above-mentioned problem. That is, in order to abolish the penetration in a joint, when wax material and a joint metal do not react or it was made the combination of the metal which does not make an alloy, this invention was realized paying attention to what a joint metal does not melt into the fused wax material (however, opposite side junction does not take place, either). It is the structure joined in metallurgy on both sides of the melt phase of an alloy in between. namely, two members which the plane of composition of 1. one [at least] member becomes from a metal -- M-X (X is an active metal) -- Junction structure of the member characterized by coming to join Metal Y to alloy M-X in metallurgy when this joint metal side consists of a metal Y which does not react with the melt of Metal M and exists in the state of solid phase at the melt temperature at the time of junction of this M-X alloy and this active metal X is spread to this metal Y.

2. Junction structure given in 1 which is alloy which uses as principal component kind or two sorts or more of metals with which above-mentioned metal M was chosen from In, Sn, Au, Ag, Cu, AL, Pd, Zn, Pb, and Cd, and is metal with which Metal Y was chosen from Cr, Mo, and W.

3. 1 above-mentioned metallurgical junction is [1] with low, or junction structure given in 2.

4. It is Structure Joined in Metallurgy on both sides of Melt Phase of Alloy in between. Two Members Which One [at Least] Member Turns into from Metal -- M-X (X is Active Metal) -- A kind or two sorts or more of metals of this metal member with which the plane of composition was chosen from (Fe, nickel, Co) at least, and a kind or two sorts or more of metals chosen from (Cr, AL, Si) with the alloy used as a principal component And junction structure of the member characterized by consisting of 1% or more of alloy if it is in Cr, it is in AL 10% or more and it is in Si 1% or more, and coming to form in the front face of this alloy the oxide film of Cr included as a

component, AL, or Si.

5. Junction structure given in 4 which is alloy which uses as principal component kind or two sorts or more of metals with which above-mentioned metal M was chosen from In, Sn, Au, Ag, Cu, AL, Pd, Zn, Pb, and Cd.

6. two members which one [at least] member turns into from a metal -- M-X (X is an active metal) -- the junction structure of the member characterized by being the structure joined in metallurgy on both sides of **** of an alloy in between, and coming to nitride this joint surface of metal.

7. Junction structure given in either of 1-6 which are metal with which above-mentioned active metal X was chosen from Ti, Zr, Nb, and Ta.

[0005]

[Embodiment of the Invention] This invention is the junction structure of a member where one [at least] member consists of a metal. That is, it is the junction structure of a metal-metal and metal-ceramic. these members -- M-X (X is an active metal) -- on both sides of the melt phase of an alloy, it is joined in between. That is, it is joined in metallurgy with the fused M-X alloy. At this time, the plane of composition of a metal member serves as Metal M from the metallic material with which the metal Y which does not form an alloy or the fused metal M, the oxide film which does not react, or the nitride was formed. When melting into the metal M which Y fused in the case of Metal Y is also the metallic material with which the oxide film and the nitride were formed again, this metal component does not melt into Metal M. However, on the other hand, it is not joined in metallurgy. When the active metal X added in M here is spread in Metal Y or an oxide film, and a nitride, a melt M-X alloy, Metal Y or a melt M-X alloy, an oxide film, or a nitride is joined in metallurgy.

[0006] 0.1 - several% of addition is enough as the active metal X added. It is 0.5 - 2% most preferably 0.1 to 5%. Since addition of excess (10% or more) hardens a M-X alloy, it is not desirable.

[0007] Since the member front face of Metal Y should just be Y at least, the whole member does not necessarily need to be Y. Metal Y could be covered on different-species material. The effective means of covering are plating, thermal spraying, and sputtering.

[0008] Metals Y are Cr, Mo, W, or these alloys, and Metal M is an alloy which uses as a principal component a kind or two sorts or more of metals chosen from In, SnZn, and Pb, Cd, AL, Au, Ag, Cu and Pd.

[0009] A kind or two sorts or more of metals with which the surface component presentation was chosen from (Fe, nickel, Co) if it was in the member by which the oxide film was formed in the front face, It is the alloy which uses as a principal component a kind or two sorts or more of metals chosen from (Cr, AL, Si), and is Cr. When AL and Si exist independently, if it is in Cr, it is in AL 10% or more and it is in Si 1% or more, 1% or more of thing is desirable. When AL, Cr, and Si coexist with Cr, Cr is 5% or more and AL and 0.5% or more of Si are desirable respectively. When AL and Si live together, 1% or more has the desirable sum of AL and Si. When Cr, AL, and Si live together, 0.5% or more of Cr has the desirable sum of AL and Si at 5% or more. The thing of these component range is precise on a front face, and its adhesion is strong, and it can form the stable oxide film. Although there is no limit with the upper limit of these elements special to Cr, when economical efficiency is taken into consideration, in AL, it is to about 10% to about 5% to about 40% at Si. An ingot will become difficult if an upper limit is exceeded. The thing from which the whole may be formed in one with the ingredient of the above-mentioned component, or it was made only for a front face to become this component is sufficient as a member. That is, what covered the thing of this component on the front face may be used. Although it is applicable by any approaches if there is no special limitation and covering of this component can be formed in covering, it conflicts in inside and reason thermal spraying is effective. If the ingredient of this component carries out oxidation annealing at 800 degrees C or more of elevated temperatures, a still more precise and thick oxide film will be formed. Moreover, you may make it form an oxide film in the front face of a joint material metal by covering a ceramic. That is, a ceramic may be covered with means, such as thermal spraying, sputtering, PVD and CVD, or a sol-gel method. If sputtering and the technique of PVD and CVD are adopted, a nitride and a carbide coat can also be formed and all are effective in this invention.

[0010] Although there is no limit special to a component if it is in the member by which the nitride was formed in the front face, the steel materials called nitriding steel are desirable.

[0011] An active metal may choose a kind or two sorts or more from Ti, Zr, Nb, Ta, and V, and they may be suitably used for it.

[0012]

[Example]

Example 1 member 1: Plate of an alumina (phi200mmx10mm thickness)

Member 2: Plate of carbon steel (phi200mmx20mm thickness)

Wax material: In-1%Ti (100 microns)

The foil of wax material was inserted among members 1 and 2, and it was heated and made 800 degrees C with the low among the vacuum (1x10 to 5 torrs). The crack occurred to the plate of an alumina. Iron had melted into wax

material (In-1%Ti) so much. Next, nickel plating was carried out, 10 microns of chromium were plated on this, and, similarly 5 microns was made with the low the plate of the carbon steel of a member 2 on the same conditions on both sides of In-1%Ti (100 microns). The alumina has been joined without being divided. As a result of gazing at a microstructure, the penetration to the inside of In of chromium was not accepted. Moreover, the penetration of the chromium to wax material was not accepted by component analysis, either. By covering chromium, the penetration of steel was prevented into In and it has checked that effectiveness was in crack prevention.

[0013] Example 2 member 1: Plate of Mo ($\phi 180\text{mm} \times 5\text{mm}$ thickness)

Member 2: Plate of a pure copper ($\phi 180\text{mm} \times 10\text{mm}$ thickness)

Wax material: Sn-1%Zr (80 microns)

The foil of wax material was inserted among members 1 and 2, and it was heated and made 850 degrees C with the low among the vacuum (1×10 to 5 torrs). The jointing material for corrugated fibreboard had curved to the bow in the direction of a pure copper. The amount of curvatures was 1000 microns. Copper had melted into wax material (Sn-1%Zr) so much. Next, thermal spraying of 100 microns and the tungsten was carried out to the plate of the pure copper of a member 2, and it carried out with the low on the same conditions on both sides of Sn-1%Zr (80 microns). The amount of curvatures was 300 microns. As a result of gazing at a microstructure, there was no penetration to the inside of Sn of a tungsten. Moreover, the penetration of the tungsten to wax material was not accepted by component analysis, either. By covering a tungsten, copper penetration was prevented into Sn and it has checked that higher efficacy was in deformation prevention.

[0014] Example 3 member 1: The plate of an alumina ($\phi 80\text{mm} \times 5\text{mm}$ thickness)

Member 2: The plate of Fe-3%C-3%AL cast iron ($\phi 80\text{mm} \times 10\text{mm}$ thickness)

Comparison Material 1: The plate of Fe-3%C cast iron ($\phi 80\text{mm} \times 10\text{mm}$ thickness)

Comparison Material 2: What carried out 100-micron thermal spraying of the nickel-10%Cr-3%AL-1% Y alloy to the plate ($\phi 80\text{mm} \times 10\text{mm}$ thickness) of Fe-3%C cast iron.

Wax material: AL-0.5%Ti (120 microns)

Among atmospheric air, the member 2 was heated at 900 degrees C for 2 hours, and was oxidized at them. The foil of wax material was inserted, respectively between members 1 and 2 and a member 1, and the comparison material 1 and 2, and it was heated and made 850 degrees C with the low among the vacuum (1×10 to 5 torrs). The alumina has been joined in members 1 and 2, without being divided. In component analysis, the penetration of the cast iron to wax material (AL-0.5%Ti) was not accepted. On the other hand in a member 1 and the comparison material 1, the alumina broke. In this combination, aluminum and cast iron alloyed and the hard and weak phase was formed. On the other hand by the member 1 and the comparison material 2, it has joined, without an alumina breaking. In component analysis, the penetration of the thermal-spraying layer to wax material (AL-0.5%Ti) was not accepted. Penetration was prevented with the oxide film of a thermal-spraying layer front face. It has checked that formation of an alloy layer was prevented and a crack could be prevented with the oxide film on the front face of a member.

[0015] Example 4 member 1: The plate of an alumina ($\phi 100\text{mm} \times 5\text{mm}$ thickness)

Member 2: The plate of the Fe-0.1%C-2%Cr steel which carried out nitriding treatment ($\phi 100\text{mm} \times 10\text{mm}$ thickness)

Comparison material: The plate of Fe-0.1%C-2%Cr steel (processing [no]) ($\phi 100\text{mm} \times 10\text{mm}$ thickness)

Wax material: Sn-0.5%Ti (100 microns)

The foil of wax material was inserted between members 1 and 2 and a member 1, and comparison material, respectively, and it was heated and made 850 degrees C with the low among the vacuum (1×10 to 5 torrs). The alumina has been joined in members 1 and 2, without being divided. In component analysis, the penetration of the iron to wax material (Sn-0.5%Ti) was not accepted. On the other hand in a member 1 and comparison material, the alumina broke. In this combination, iron melted into Sn and the hard and weak phase was formed. It has checked that formation of an alloy layer was prevented and a crack could be prevented by the nitride on the front face of a member.

[0016] Example 5 member 1: The plate of silicon carbide ($\phi 80\text{mm} \times 2\text{mm}$ thickness)

Member 2: The plate of Fe-42%nickel steel ($\phi 80\text{mm} \times 10\text{mm}$ thickness) (it is 30-micron thermal spraying about high purity alumina to a plane of composition)

Comparison Material 1: The plate of Fe-42%nickel steel (processing [no]) ($\phi 80\text{mm} \times 10\text{mm}$ thickness)

Comparison material 2: The plate of the Fe-42%nickel steel which covered TiC with 0.5 microns and PVD to the plane of composition ($\phi 80\text{mm} \times 10\text{mm}$ thickness)

Wax material: Sn-5%Ag-1%Zr (100 microns)

The foil of wax material was inserted, respectively between members 1 and 2 and a member 1, and the comparison material 1 and 2, and it was heated and made 850 degrees C with the low among the vacuum (1×10 to 5 torrs). The ceramic has been joined in members 1 and 2, without being divided. On the other hand in a member 1 and the comparison material 1, the plate of a ceramic broke. In this combination, wax material and 42nickel steel alloyed

and the hard and weak phase was formed. On the other hand by the member 1 and the comparison material 2, it has joined, without a ceramic breaking. In component analysis, the penetration of 42nickel steel to wax material was not accepted. Penetration was prevented with the PVD coat of TiC. It has checked that formation of an alloy layer was prevented and a crack could be prevented with the ceramic film on the front face of a member.

[0017]

[Effect of the Invention] As a full account was given above, this invention has the crack of joint material, and the description which can carry out [minimum]-izing of the deformation, and demonstrates great power to junction of the large-sized member of a metal and a ceramic ingredient.

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(54)【発明の名称】 部材の接合構造

(57)【要約】

【課題】 膨脹係数の異なる二つの部材の接合歪みを小さくできる接合構造に係わる。

【解決手段】 少なくとも一方の部材の接合面が金属からなる二つの部材がM-X (Xは活性金属)なる合金の融体相を間に挟んで冶金的に接合された構造であって、該接合部金属面が金属Mの融体と反応せず、かつ該M-X合金の接合時の融体温度では固相状態で存在する金属Yからなり、該金属Yに該活性金属Xが拡散することによって合金M-Xと金属Yが冶金的に接合されてなることを特徴とする。

【特許請求の範囲】

【請求項1】少なくとも一方の部材の接合面が金属からなる二つの部材がM-X（Xは活性金属）なる合金の融体相を間に挟んで冶金的に接合された構造であって、該接合部金属面が金属Mの融体と反応せず、かつ該M-X合金の接合時の融体温度では固相状態で存在する金属Yからなり、該金属Yに該活性金属Xが拡散することによって合金M-Xと金属Yが冶金的に接合されてなることを特徴とする部材の接合構造。

【請求項2】上記金属MがIn, Sn, Au, Ag, Cu, Al, Pd, Zn, Pb, Cd, の中から選ばれた一種あるいは二種以上の金属を主成分にする合金であって、金属YがCr, Mo, Wから選ばれた金属である請求項1に記載の接合構造。

【請求項3】上記冶金的接合がロー付である請求項1あるいは2に記載の接合構造。

【請求項4】少なくとも一方の部材が金属からなる二つの部材が、M-X（Xは活性金属）なる合金の融体相を間に挟んで冶金的に接合された構造であって、該金属部材の少なくとも接合面が、(Fe, Ni, Co)の中から選ばれた一種あるいは二種以上の金属と、(Cr, Al, Si)の中から選ばれた一種あるいは二種以上の金属を主成分とする合金で、かつCrにあっては10%以上、Alにあっては1%以上、Siにあっては1%以上の合金からなり、該合金の表面に成分として含むCrあるいはAlあるいはSiの酸化膜が形成されてなることを特徴とする部材の接合構造。

【請求項5】上記金属MがIn, Sn, Au, Ag, Cu, Al, Pd, Zn, Pb, Cd, の中から選ばれた一種あるいは二種以上の金属を主成分にする合金である請求項4に記載の接合構造。

【請求項6】少なくとも一方の部材が金属からなる二つの部材がM-X（Xは活性金属）なる合金の融体相を間に挟んで冶金的に接合された構造であって、該接合部金属表面が窒化されてなることを特徴とする部材の接合構造。

【請求項7】上記活性金属Xが、Ti, Zr, Nb, Taの中から選ばれた金属である請求項1～6のいずれかに記載の接合構造。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は、部材の接合構造に関わり、さらに詳しくは、膨脹係数の異なる二つの部材の接合歪みを小さくできる接合構造に係わるものである。

【0002】

【従来の技術】金属-金属あるいは金属-セラミックの接合で、熱膨張係数の異なる部材を接合する際、柔らかい金属をろう材に使用して接合する場合が多い。例えば、In, Sn, Zn, Pb, Cd等の低融点金属、Ag, Au, Pt, Pd等の貴金属はおしなべて柔らかい

金属で、これらを用いて接合すると熱膨張係数の違いによって生ずる熱歪はこれらの金属の塑性変形あるいは弾性変形によって緩和される。この際問題は、これらろう材金属の中に接合部材の接合面金属の溶け込みが起こることである。この結果、ろう材金属が硬化し、ろう材金属の変形抵抗が大きくなり、接合部の残留応力が大きくなる。部材の一方がセラミックの場合、最悪の場合、セラミックが破壊されることがある。この溶け込みは冶金学的に不可避な現象であるので、従来は溶け込みによる変形抵抗の増大は容認した上で、いかにして残留応力を小さくするかに考慮が払われている。最も一般的な方法は中間的な膨脹係数を有する中間層を挿入することである。中間層の挿入によって、隣り合う部材間の熱膨張差をできるだけ小さくして残留応力を小さくすることが行われているにすぎず、根本的な解決は計られていないのが現状である。

【0003】

【発明が解決する課題】本発明は、かかる状況に鑑みてなされたもので、その目的とするところは、接合面金属の溶け込みを皆無あるいは極小にすることができる新しい接合構造を提供せんとするものである。

【0004】

【課題を解決するための手段】本発明者は上記問題に関して鋭意研究を行った結果、次の知見を得た。すなわち、接合部での溶け込みをなくすためには、ろう材と接合部金属が反応しない、あるいは合金を作らない金属の組合わせにすると、溶融したろう材に接合部金属は溶け込むことがない（しかし反面接合も起こらないが）ことに着目し、本発明に思い至った。すなわち、

1. 少なくとも一方の部材の接合面が金属からなる二つの部材がM-X（Xは活性金属）なる合金の融体相を間に挟んで冶金的に接合された構造であって、該接合部金属面が金属Mの融体と反応せず、かつ該M-X合金の接合時の融体温度では固相状態で存在する金属Yからなり、該金属Yに該活性金属Xが拡散することによって合金M-Xと金属Yが冶金的に接合されてなることを特徴とする部材の接合構造。

2. 上記金属MがIn, Sn, Au, Ag, Cu, Al, Pd, Zn, Pb, Cd, の中から選ばれた一種あるいは二種以上の金属を主成分にする合金であって、金属YがCr, Mo, Wから選ばれた金属である1に記載の接合構造。

3. 上記冶金的接合がロー付である1あるいは2に記載の接合構造。

4. 少なくとも一方の部材が金属からなる二つの部材が、M-X（Xは活性金属）なる合金の融体相を間に挟んで冶金的に接合された構造であって、該金属部材の少なくとも接合面が、(Fe, Ni, Co)の中から選ばれた一種あるいは二種以上の金属と、(Cr, Al, Si)の中から選ばれた一種あるいは二種以上の金属を主

成分とする合金で、かつCrにあっては10%以上、ALにあっては1%以上、Siにあっては1%以上の合金からなり、該合金の表面に成分として含むCrあるいはALあるいはSiの酸化膜が形成されてなることを特徴とする部材の接合構造。

5. 上記金属Mが、In, Sn, Au, Ag, Cu, AL, Pd, Zn, Pb, Cd, の中から選ばれた一種あるいは二種以上の金属を主成分にする合金である4に記載の接合構造。

6. 少なくとも一方の部材が金属からなる二つの部材がM-X (Xは活性金属) なる合金の融汰を間に挟んで冶金的に接合された構造であって、該接合部金属表面が窒化されてなることを特徴とする部材の接合構造。

7. 上記活性金属Xが、Ti, Zr, Nb, Taの中から選ばれた金属である1~6のいずれかに記載の接合構造。

【0005】

【発明の実施の形態】本発明は、少なくとも一方の部材が金属からなる部材の接合構造である。すなわち、金属-金属、金属-セラミックの接合構造である。これら部材はM-X (Xは活性金属) なる合金の融体相を間に挟んで接合されている。つまり溶融したM-X合金によって冶金的に接合されている。このとき金属部材の接合面は金属Mとは合金を形成しない金属Yあるいは溶融した金属Mと反応しない酸化膜あるいは窒化膜が形成された金属材料からなる。金属Yの場合、Yは溶融した金属Mに溶け込むこともないし、また、酸化膜、窒化膜が形成された金属材料の場合、この金属成分が金属Mに溶け込むこともない。しかし反面、冶金的に接合されることもない。ここでMの中に添加された活性金属Xが金属Yあるいは酸化膜、窒化膜に拡散することによって融体M-X合金と金属Yあるいは融体M-X合金と酸化膜あるいは窒化膜が冶金的に接合される。

【0006】添加される活性金属Xは0.1~数%の添加で十分である。好ましくは0.1~5%、最も好ましくは0.5~2%である。過度(10%以上)の添加はM-X合金を硬くするので好ましくない。

【0007】金属Yは、少なくとも部材表面がYであればよいので、部材全体が必ずしもYである必要はない。異種材の上に金属Yが被覆されたものでもよい。被覆の有効な手段はメッキ、溶射、スパッタリングである。

【0008】金属YはCr, Mo, Wあるいはこれらの合金であり、金属Mは、In, Sn, Zn, Pb, Cd, AL, Au, Ag, Cu, Pdの中から選ばれた一種あるいは二種以上の金属を主成分にする合金である。

【0009】表面に酸化膜が形成された部材にあっては、表面の成分組成が、(Fe, Ni, Co)の中から選ばれた一種あるいは二種以上の金属と、(Cr, AL, Si)の中から選ばれた一種あるいは二種以上の金属を主成分とする合金で、かつCr, AL, Siが単独

で存在する場合、Crにあっては10%以上、ALにあっては1%以上、Siにあっては1%以上のものが好ましい。CrとAL、CrとSiが共存する場合、Crは5%以上で、AL, Siはそれぞれ0.5%以上が好ましい。AL, Siが共存する場合、AL, Siの和が1%以上が好ましい。Cr, AL, Siが共存する場合、Crは5%以上でAL, Siの和が0.5%以上が好ましい。これらの成分範囲のものは表面に緻密で、密着性が強く、安定した酸化膜が形成できる。これらの元素の上限は、Crには特別な制限はないが、経済性を考慮すると、40%程度まで、ALでは5%程度まで、Siでは10%程度までである。上限を越えると溶裂が困難になる。部材は、全体が上記成分の材料で一体的に形成されていてもよく、あるいは表面だけこの成分になるようにしたものでもよい。つまりこの成分のものを表面に被覆したものでもよい。被覆に当たって、特別な限定はなく、本成分の被覆が形成できればいかなる方法でも適用できるが、中でもとりわけ溶射が有効である。本成分の材料は、高温800℃以上で酸化焼鈍するとさらに緻密で厚い酸化膜が形成される。また、接合部材金属の表面にセラミックを被覆することによって酸化膜を形成するようにしてもよい。すなわち、セラミックを溶射、スパッタリング、PVD, CVD、あるいはゾルーゲル法等の手段で被覆してもよい。スパッタリング、PVD, CVDの手法を採用すると窒化物、炭化物被膜も形成でき、いずれも本発明には有効である。

【0010】表面に窒化膜が形成された部材にあっては、成分に特別な制限はないが、窒化鋼と称せられる鋼材が好ましい。

【0011】活性金属は、Ti, Zr, Nb, Ta, Vの中から一種あるいは二種以上を選んで適宜使用してもよい。

【0012】

【実施例】

実施例1

部材1: アルミナの板(φ200mm×10mm厚さ)

部材2: 炭素鋼の板(φ200mm×20mm厚さ)

ろう材: In-1%Ti (100ミクロン)

部材1と2の間にろう材の箔を挟み、真空中(1×10⁻⁵トル)800℃に加熱してロー付した。アルミナの板にはクラックが発生した。ろう材(In-1%Ti)には鉄が多量に溶け込んでいた。次に、部材2の炭素鋼の板に5ミクロン、ニッケルメッキし、この上にクロムを10ミクロンメッキし、同じくIn-1%Ti (100ミクロン)を挟んで同じ条件でロー付した。アルミナは割れることなく接合できた。ミクロ組織を観察した結果、クロムのIn中への溶け込みは認められなかった。また成分分析でも、ろう材へのクロムの溶け込みは認められなかった。クロムを被覆することによって、

In中へ銅の溶け込みが阻止され、割れ防止に効果があることが確認できた。

【0013】実施例2

部材1: Moの板(φ180mm×5mm厚さ)

部材2: 純銅の板(φ180mm×10mm厚さ)

ろう材: Sn-1%Zr(80ミクロン)

部材1と2の間にろう材の箔を挟み、真空中(1×10^{-5} トール) 850℃に加熱してロー付した。接合材は純銅の方向に弓なりに反っていた。反り量は、1000ミクロンであった。ろう材(Sn-1%Zr)には銅が多量に溶け込んでいた。次に、部材2の純銅の板に100ミクロン、タングステンを溶射し、Sn-1%Zr(80ミクロン)を挟んで同じ条件でロー付した。反り量は、300ミクロンであった。ミクロ組織を観察した結果、タングステンのSn中への溶け込みはなかった。また成分分析でも、ろう材へのタングステンの溶け込みは認められなかった。タングステンを被覆することによって、Sn中へ銅の溶け込みが阻止され、変形防止に著効があることが確認できた。

【0014】実施例3

部材1: アルミナの板(φ80mm×5mm厚さ)

部材2: Fe-3%C-3%AL 鋳鉄の板(φ80mm×10mm厚さ)

比較材1: Fe-3%C 鋳鉄の板(φ80mm×10mm厚さ)

比較材2: Fe-3%C 鋳鉄の板(φ80mm×10mm厚さ)にNi-10%Cr-3%AL-1%Y合金を100ミクロン溶射したもの。

ろう材: AL-0.5%Ti(120ミクロン)

部材2は大気中900℃に2時間加熱して酸化処理した。部材1と2、および部材1と比較材1、2の間にそれぞれろう材の箔を挟み、真空中(1×10^{-5} トール) 850℃に加熱してロー付した。部材1と2ではアルミナは割れることなく接合できた。成分分析では、ろう材(AL-0.5%Ti)への鋳鉄の溶け込みは認められなかった。一方部材1と比較材1ではアルミナが割れた。この組み合わせでは、アルミニウムと鋳鉄が合金化し、硬くて脆い相が形成されていた。一方部材1と比較材2ではアルミナが割れることなく接合できた。成分分析では、ろう材(AL-0.5%Ti)への溶射層の溶け込みは認められなかった。溶射層表面の酸化膜で溶け込みが阻止されていた。部材表面の酸化膜によって合金層の形成を阻止し、割れを防止できることが確認できた。

【0015】実施例4

部材1: アルミナの板(φ100mm×5mm厚さ)

部材2: 窒化処理したFe-0.1%C-2%Cr 鋼の板(φ100mm×10mm厚さ)

比較材: Fe-0.1%C-2%Cr 鋼の板(無処理)(φ100mm×10mm厚さ)

ろう材: Sn-0.5%Ti(100ミクロン)

部材1と2、および部材1と比較材の間にそれぞれろう材の箔を挟み、真空中(1×10^{-5} トール) 850℃に加熱してロー付した。部材1と2ではアルミナは割れることなく接合できた。成分分析では、ろう材(Sn-0.5%Ti)への鉄の溶け込みは認められなかった。一方部材1と比較材ではアルミナが割れた。この組み合わせでは、鉄がSn中に溶け込んで硬くて脆い相が形成されていた。部材表面の窒化膜によって合金層の形成を阻止し、割れを防止できることが確認できた。

【0016】実施例5

部材1: 炭化ケイ素の板(φ80mm×2mm厚さ)

部材2: Fe-42%Ni 鋼の板(φ80mm×10mm厚さ)(接合面に高純度アルミナを30ミクロン溶射)

比較材1: Fe-42%Ni 鋼の板(無処理)(φ80mm×10mm厚さ)

比較材2: 接合面にTiCを0.5ミクロン、PVDで被覆したFe-42%Ni 鋼の板(φ80mm×10mm厚さ)

ろう材: Sn-5%Ag-1%Zr(100ミクロン)

部材1と2、および部材1と比較材1、2の間にそれぞれろう材の箔を挟み、真空中(1×10^{-5} トール) 850℃に加熱してロー付した。部材1と2ではセラミックは割れることなく接合できた。一方部材1と比較材1ではセラミックの板が割れた。この組み合わせでは、ろう材と42Ni 鋼が合金化し、硬くて脆い相が形成されていた。一方部材1と比較材2ではセラミックが割れることなく接合できた。成分分析では、ろう材への42Ni 鋼の溶け込みは認められなかった。TiCのPVD被膜で溶け込みが阻止されていた。部材表面のセラミック膜によって合金層の形成を阻止し、割れを防止できることが確認できた。

【0017】

【発明の効果】以上詳記したように本発明は接合部材の割れ、変形を極小化できる特徴を有し、金属、セラミック材料の大型部材の接合に多大の威力を発揮するものである。